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EFFECTS OF BAIT PLACEMENT ON THE ATTRACTIVENESS AND CONSUMPTION OF SINGLE LETHAL DOSE COYOTE BAITS BY WILDLIFE AND CATTLE

by

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ABSTRACT

Single lethal dose (SLD) baits for coyote control pose a potential poisoning hazard to nontarget wildlife consuming the baits. A field study was conducted in the Missouri River Breaks of Montana during September-November 1981, using 1 ounce tallow-beeswax-fishmeal baits to investigate the influence of bait placement on visitation and consumption by wildlife and cattle. Baits were placed in 3 ways: buried, elevated, and on the ground surface within prepared dirt circles and the tracks of wildlife visitors and consumption of baits were recorded. Coyotes were attracted to bait sets and readily consumed baits; visitation rates were 76.5 for surface baits, 63.2 for buried baits, 48.0 for elevated baits, and 35.5 for controls. Other species attracted to baits included cattle, small mammals, magpies, skunks, and raccoons. Burying baits eliminated magpie visits but had no apparent effect on visits by small mammals, cattle, skunks or raccoons. Elevated baits were visited less by magpies and skunks, but had no apparent effect on visits by small mammals, cattle or raccoons. Burying baits reduced the average amount of bait consumed per visit by magpies but had little effect on consumption by coyotes, small mammals, skunks and magpies. In comparison with surfact baits, elevated baits appeared to have less average bait consumption per visit by small mammals and magpies. Visitation and consumption rates of small mammals increased as the study progressed indicating a tendency to become accustomed to bait sets, possibly as a food source. After day 25, small mammal visits and consumption of baits were so intense that baits were usually removed within 24 hours of placement. Low visitation by coyotes at elevated baits was influenced by an initial reluctance to visit these sets. The elevated bait method used in this study may not be viable for operational coyote control. It does offer an increased margin of safety from poisoning for small mammals, magpies, and skunks. Buried baits may be adequately accepted by coyotes and may eliminate poisoning of magpies but may still present a hazard for certain nontarget wildlife species. Cattle, deer, and lagomorphs were frequent visitors but did not consume baits.

Technical Report 82-1
March, 1982

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INTRODUCTION

Small baits containing an acute toxicant have been used for control of coyotes preying on livestock and wild ungulates. Baits containing a dose lethal to a single coyote (SLD Baits) have contained toxicants such as 1080 (sodium monofluoroacetate), strychnine, and thallium. At this time, 1080 is used discriminately in 35-55 gram marrow or meat baits to control coyotes (*Canis latrans*) and wolves (*Canis lupus*) in British Columbia (G. Trolitsch, pers. comm.). Several U.S. agencies have indicated an interest in using small baits containing 1080 to control coyotes. In 1977 the State of Montana submitted a request to register "single lethal dose baits" containing 1080 to control coyotes (Nesse 1977), and in 1981 information was presented to EPA to further support this use. The U.S. Fish and Wildlife Service (USFWS) has conducted research dealing with the acceptance by coyotes of various SLD bait matrices, scents to attract coyotes to baits, and various delivery techniques (Tigner *et al*. 1981).

One concern associated with the use of acute toxicants is the potential for primary poisoning of nontarget wildlife. In small coyote baits, this hazard can be reduced by selective placement. With 1080 the dosages can be kept small because of the specificity of 1080 to canids thereby lessening the hazards to some less sensitive wildlife. Despite reducing these hazards the potential still exists for nontarget poisoning by small baits containing a toxicant. This potential is related not only to the dosage of toxicant in baits, but also to the attractiveness of baits to various wildlife and the degree of success in attracting and eliciting coyotes or other target animals to consume a bait. Several studies have investigated methods of bait placement and the resultant effect on coyote acceptance (Tigner *et al*. 1981; Servheen and Spillett 1981). Servheen and Spillett (1981) recorded coyote visits to lard-beeswax baits that were elevated, hidden, buried, or placed on the ground. Very little difference in coyote visitations among the four placements was seen; however, the lowest visitation and acceptance rate was for buried baits. The USFWS, in a similar study, found that visits and acceptance were lowest for elevated baits (Tigner *et. al*. 1981).

Very little information has been collected concerning the attractiveness of small baits to nontarget wildlife. Tigner *et. al*. (1981) found that buried baits were taken less by crows (*Corvus brachyrhynchos*) and buried or elevated baits were taken less by rodents. To accurately assess the potential hazards of primary poisoning, more field information is necessary on the attractiveness and response of wildlife to small baits.

The following study was conducted to investigate the effects of bait placement on visitation and consumption of baits by wildlife and cattle. Three placements, buried, elevated, and uncovered on the ground surface, were investigated in relation to the following questions:

1. Can coyotes be attracted to small baits and, if so, to what extent does bait placement influence coyote visitation and consumption?

2. What animals, other than coyotes, are attracted to and consume small baits?

3. Will different bait placements influence the rate of visitation and consumption by animals other than coyotes?

METHODS AND MATERIALS

Fieldwork was conducted from September 8 to November 16, 1981, on the Missouri River Breaks in northeast Fergus County, Montana. Basically, the study encompassed the area from the Musselshell Trail north to the Missouri River, an area in the southwest corner of the Charles M. Russell (CMR) National Wildlife Refuge. East and west borders of the study area were Highway 191 and Skyline Trail, respectively (Fig. 1).

Vegetation and topography of the breaks were discussed in detail by Mackie (1970). Basically, the area consists of rugged breaks or coulees that drain into the Missouri River. Vegetation of ridge tops is primarily sagebrush-grass (_Artemisia tridentata_, _Agropyron spicatum_) and the unstable shale slopes are covered mainly by pine-juniper or fir-juniper (_Pinus ponderosa_, _Juniperus scopulorum_, _Pseudotsuga menziesii_). Greasewood-rabbitbrush communities (_Sarcobatus vermiculatus_, _Chrysothamnus nauseosus_) are common bottomland and coulee bottom types; however, greasewood is commonly mixed with sagebrush on ridges and saline slopes. The narrow alluvial plain of the Missouri River, an area of heavy coyote use, is vegetated primarily with cottonwood, willow, rose, and snowberry (_Populus deltoides_, _Salix spp._, _Rosa spp._, and _Symphoricarpos spp._) interspersed with grassy meadows, some of which are harvested for hay.

The breaks area was selected as a study site because of the information already collected there on wildlife populations and ecology, namely that for mule (_Odocoileus hemionus_) and white-tailed deer (_O. virginianus_), small mammals and coyotes (Hamlin 1980a, 1980b, Pyrah 1980, Schladweiler 1980, Trout 1978, Mackie 1970). Of particular importance, Pyrah (1980) documented many traditional coyote denning areas and this information was used in selecting specific study stations.

To be effective in attracting coyotes SLD baits should be located in areas of coyote activity. Consequently, in addition to relying on the denning areas described by Pyrah (1980), siren surveys were conducted just prior to the study and areas in which multiple answers were elicited were investigated as potential study stations. Potential stations were investigated for the presence of coyote activity indicated by recent tracks or scats. Within areas of observed coyote activity, transects were established along infrequently traveled roads on ridge tops and along the Missouri River flood plain, and along the bottoms of draws. Pyrah (1980) suggested that ridgetop areas, coulee bottoms, and the Missouri River approximated certain denning area boundaries that might be traveled frequently by coyotes and used as scent marking and howling sites.

The scent station technique for monitoring coyote populations (Linhart and Knowlton 1975) was used to record visits and responses of wildlife to

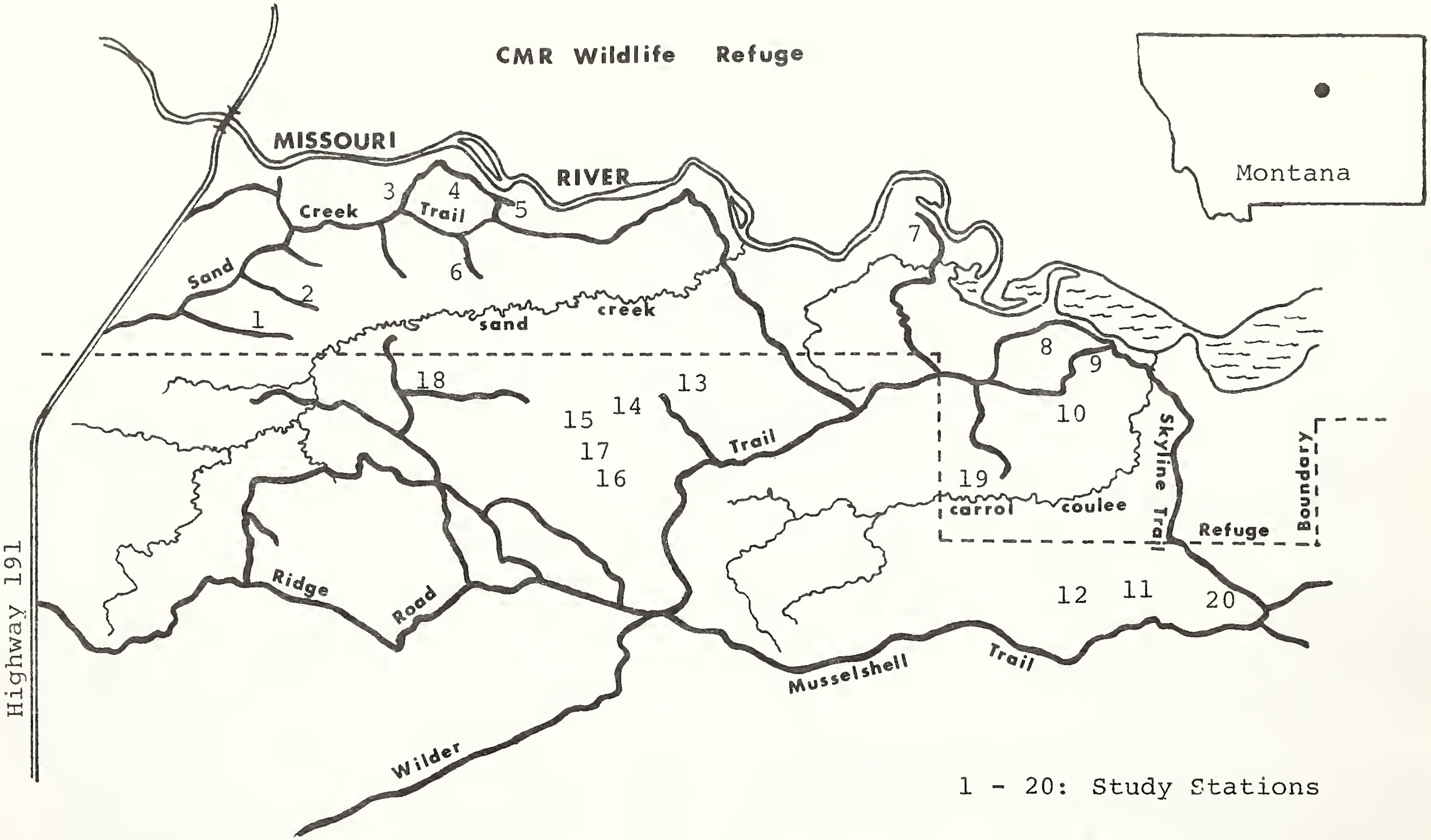


Figure 1. Missouri River Breaks study area: major roads, major drainages and study stations.

three types of bait placement and a control. The scent station technique involves the use of a carefully prepared circle of sifted soil (scent station) to record the tracks of coyotes visiting an attractant.

At each transect four scent stations were prepared 300 meters apart along a linear transect. Scent stations were one meter in diameter, cleared of vegetation and debris, and sifted over with a layer of fine soil from a 1.5 mm. mesh screen.

Three methods of bait placement and a control were randomly designated to scent stations along the transect. Each transect therefore consisted of four scent stations each with a different bait placement (buried, elevated, surface, and control) randomly sequenced so that each transect was independent of all others. Statisticians suggested that this arrangement would offer more power to a statistical analysis of results.

Baits were presented in the following manner: Buried baits were placed in a depression in the middle of scent stations and covered with 1-2 cm. of screened soil. Surface baits were placed in the middle of scent stations and no attempt was made to camouflage the bait. Initially, elevated baits were placed 45.7 cm. (18 inches) above the ground on a wire bent at 90° to hold a bait. However, after nine days, wires were replaced with sticks to elevate baits to the same height in a more natural presentation. Controls consisted only of a prepared scent station without bait or attractant and served to record visual responses of wildlife to the cleared circles. A total of 20 transects (80 scent stations) were established.

So that a bait matrix palatable to coyotes could be selected, considerable advice from Animal Damage Control (ADC) personnel was gathered and a review of recent pertinent studies was conducted. Bait acceptance studies (Servheen and Spillett 1981, Tigner _et al_. 1981) indicated that coyotes prefer tallow first, lard second, and meat baits third, although differences in acceptance among these three matrices were not statistically significant. For this study, tallow was selected as the basic bait matrix and 15% beeswax was added to improve handling and raise the bait melting temperature.

Preparation of baits involved melting beeswax and tallow[1] together in a cake pan. The mixture was cooled until it had just begun to solidify and then cut into 3.18 cm. (1.25 inch) cubes that weighed approximately 28.35 grams (1 ounce) each. Baits were rolled in fishmeal to prevent sticking and kept frozen until use.

A commercially prepared abbreviated version of synthetic fermented egg (SFE) (Bullard _et al_. 1978) was used as a coyote attractant at each baited scent station. About 5-7 drops were placed daily on a wooden stake within 2 meters of the scent station. Placing SFE near the bait, although atypical of certain envisioned operational uses of SLD baits, helped to assure that coyotes would be attracted to an area near the bait. SFE was selected over several apparently equally effective commercial lures of unknown composition. In comparison with other lures SFE had been consistently as good or better in terms of attracting coyotes (Turkowski and Popelka 1980, Tigner _et al_. 1981)

[1] Bleachable, fancy beef tallow, Midland Empire Packing, Billings, MT.

and had the added advantage of a known formula that could be reproduced consistently. As the study progressed, it was apparent that daily replacement of SFE was unnecessary. Beginning on day 33 of the study, scent was replaced at 4 day intervals or after precipitation.

Scent stations were checked daily for the presence of tracks. Tracks were identified to species as accurately as possible and recorded. When one or more tracks of a single species were present a "visit" was recorded and no attempt was made to record the intensity of the visit or number of visitors. For all visits, the portion of the bait consumed was estimated in percent. Scent stations were brushed smooth, redusted if necessary, and disturbed or partially consumed baits replaced daily as necessary.

Scent stations were classified as operable or inoperable depending upon their condition for recording tracks. An operable station was one in operation for 24 hours. Stations became inoperable for various reasons that included precipitation, destruction by cattle (_Bos taurus_), and vandalism.

Visitation indices were computed similar to the USFWS predator survey (Linhart and Knowlton 1975). These indices provided a convenient method for comparing the visit rates for a given species to various types of bait placement. The variable of unequal observations due to inoperable stations is removed. To compute indices, the total number of visits by a given species to a particular bait placement was divided by the total number of operable nights for that presentation and the result multiplied by 1000.

Average consumption per visit was computed for various wildlife species so that the effects of placement on bait consumption could be compared. Only data from scent stations with a single visitor were used to compute average bait consumption. Scent stations with more than one visitor for a single night were disregarded because a determination could not be made in most cases as to which visitor, if any, consumed the bait. Average bait consumption computed over the entire study did not give any insight into possible temporal variations in bait consumption related to the length of time a station had been in operation. Therefore, average daily bait consumption per day was computed for the duration of the study. Some difficulty was encountered in generating these data. Not all stations became initially operable on the same date, and interruptions in data collection occurred because of inclement weather. To resolve these problems, average daily bait consumption was computed by averaging data from all stations for day one of station operation (and consecutive days). In other words, all data from day one, and for subsequent days of station operation, were averaged regardless of the date the station first became operable. Coyotes and small mammals were the only visitors for which data were collected in numbers sufficient to make such an analysis. Temporal changes in average visitation rates were likewise determined for small mammals, coyotes, magpies and deer. Temporal variations in visitation rates and bait consumption were displayed graphically as averages calculated for 3 day periods.

To better characterize the small mammal population on the study area, snap trap and live trap surveys were conducted at the end of the study on transects representative of the habitat types on the study area.

Visitation data were analyzed statistically using an analysis of variance with an arc-sine transformation. In addition, all treatment means as a group were compared with the control. Significant differences among means obtained from the arc-sine transformation were calculated using Duncan's multiple range test.

RESULTS

More than 550 observations were made at each type of bait placement (range 555 - 592). Total visits were 1524 for small mammals, 290 for cattle, 127 for coyotes, 118 for mule deer and white-tailed deer combined, 91 for magpies (Pica pica), 38 for skunks (Mephitis mephitis), 28 for lagomorphs, and 13 for raccoons (Procyon lotor). A summary of operable scent station nights and total visits by animals encountered on the study area is given in Appendices I and II.

Identification to species was possible for most larger bird or mammal tracks in the scent circles. Small mammals, the most common visitors, could not be identified consistently to species and were thus grouped. Visitation indices are given in Table 1 and results of statistical analyses of visitation data are presented in Table 1 and Fig. 2. Common species or groups are discussed below in order of their frequency of occurrence.

Small Mammals

Several species of small mammals visited stations, namely Peromyscus maniculatus, Dipodomys (prob. ordii), and Microtus spp. The group, small mammals, includes these species and possibly others. However, the small mammal population was apparently composed primarily of P. maniculatus. Snap and live trap surveys, ran for a total of 185 trap nights, resulted in 85 P. maniculatus captures and no other species. Biologists on the study area also indicated that population numbers of Peromyscus were high during 1981 (Ken Hamlin, pers. comm.). Dipodomys sp. and Microtus spp. were observed on the transects.

Small mammals were apparently attracted equally to all three bait placements. Indices among baited stations were not statistically different but the control was significantly lower from each baited station (Fig. 2). In terms of the effect of bait placement on average consumption per visit, elevated baits had the least and surface baits had the most when averaged for the entire study (Table 2).

Small mammal visitation rates plotted temporally indicated that visitation to surface and elevated baits increased with the length of time stations had been in operation (Fig. 3). Conversely, visitation to control stations decreased over time. The visitation rate to surface baits was higher than that for either buried or elevated baits until about the 23rd day of station operation. After that time visitation rates at all types of bait placement reached a plateau of intensity and were essentially the same.

Average bait consumption per day by small mammals increased over time until a saturation point approaching 70 to 90% consumption per day was reached at about day 25 of station operation (Fig. 4). Prior to that time, bait consumption was greatest at surface baits; however, after day 25 no difference

Table 1. Visitation indices[1] of wildlife and cattle to SLD baits buried, placed on the ground, elevated and to controls.

Species	Buried Baits	Surface Baits	Elevated Baits	Control	Analysis of Variance (P-value)	All Treatment Means vs. Control (P-value)
Small Mammals	848.2[2]	849.2	817.4	165.5	0.00	0.00
Cattle	162.7	123.5	135.4	70.7	0.01	0.00
Coyotes	63.2	76.5	48.0	35.5	0.08	0.05
Deer	54.1	39.9	28.4	82.8	0.01	0.02
Skunks	34.2	22.6	10.7	0.0	0.01	0.01
Raccoons	7.2	6.9	5.3	3.4	N.S.	N.S.
Lagomorphs	3.6	19.1	5.3	20.3	N.S.	N.S.
Chipmunks	0.0	5.2	3.6	0.0	N.C.[3]	N.C.
Badgers	0.0	0.0	1.8	1.7	N.C.	N.C.
Elk	0.0	1.7	0.0	0.0	N.C.	N.C.
Pronghorn	0.0	1.7	0.0	0.0	N.C.	N.C.
Magpies	9.0	87.0	58.7	5.1	0.04	0.05
Sharp-tailed Grouse	0.0	0.0	0.0	1.7	N.C.	N.C.
Doves	0.0	0.0	1.8	0.0	N.C.	N.C.
Unknown Birds	3.6	1.7	5.3	3.4	N.C.	N.C.
Insects	3.6	19.1	3.6	0.0	0.02	N.S.

[1] Visitation Index = $\frac{\text{Total Visits by Given Species}}{\text{Total Operable Station Nights}} \times 1000$.

[2] For percent visitation, move decimal one place to the left.

[3] N.C. = Not Calculated because insufficient data.

Figure 2. Significant differences among visitation indices computed using Duncan's multiple-range test. Any types of bait placement connected by a bar, or with a bar on the same level, are not significantly different.

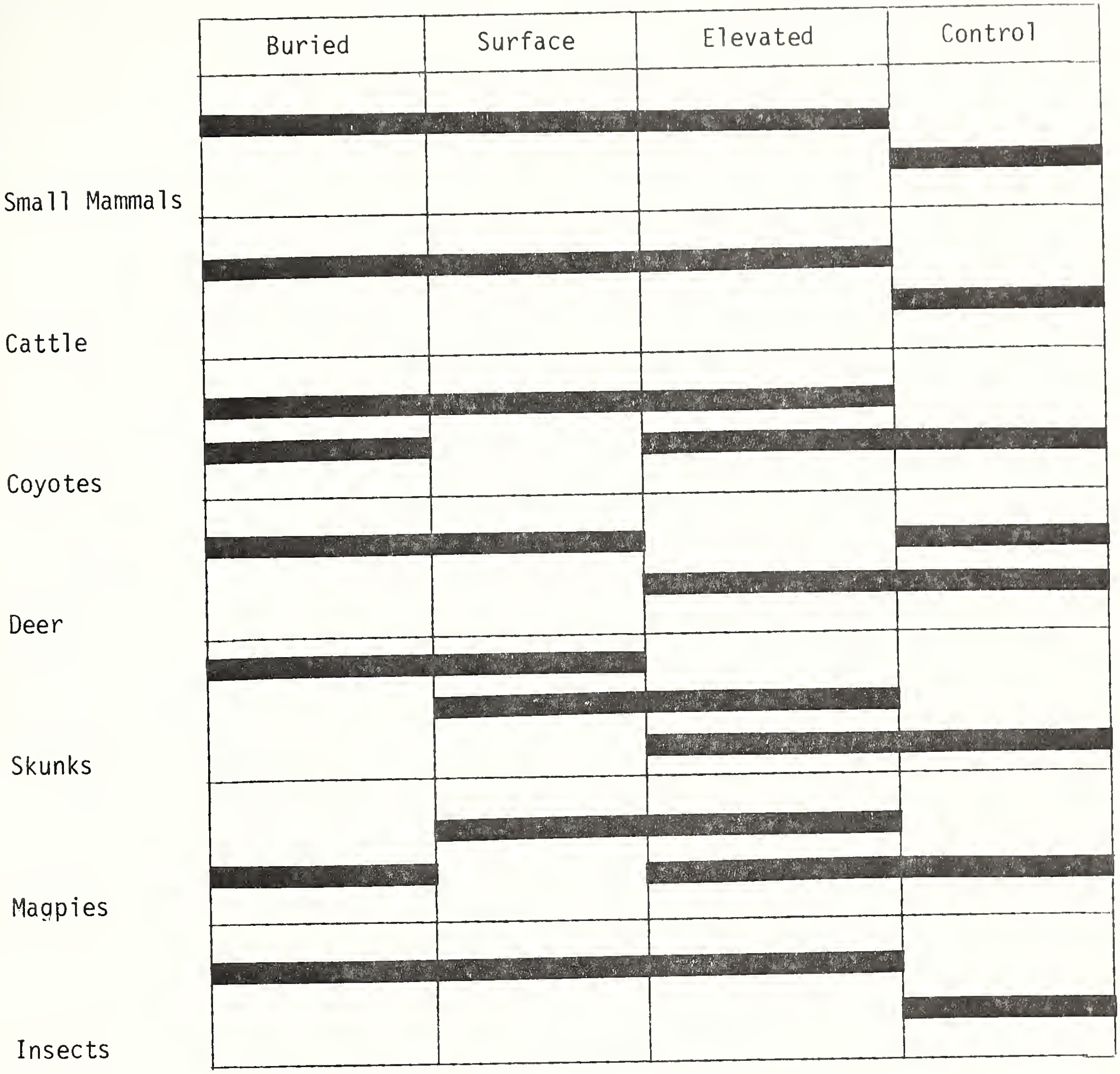


Table 2. Average portion of an SLD bait consumed per visit for 3 methods of bait placement. To assign bait consumption to a species with certainty, only cases where one species visited a bait were used to generate average bait consumption per visit.

Species	BURIED BAITS		SURFACE BAITS		ELEVATED BAITS	
	Total Visits	Bait Consumed per visit (percent)	Total Visits	Bait Consumed per visit (percent)	Total Visits	Bait Consumed per visit (percent)
Small Mammals	380	68	388	72	403	54
Cattle	12	25	8	50	10	10
Coyotes	19	84	18	94	19	90
Magpies	1	0	12	92	13	55
Deer	11	0	1	0	8	0
Skunks	4	100	5	100	1	100
Raccoons	1	100	1	100	0	0

Figure 3. Temporal changes in average visitation indices to SLD baits for small mammals.

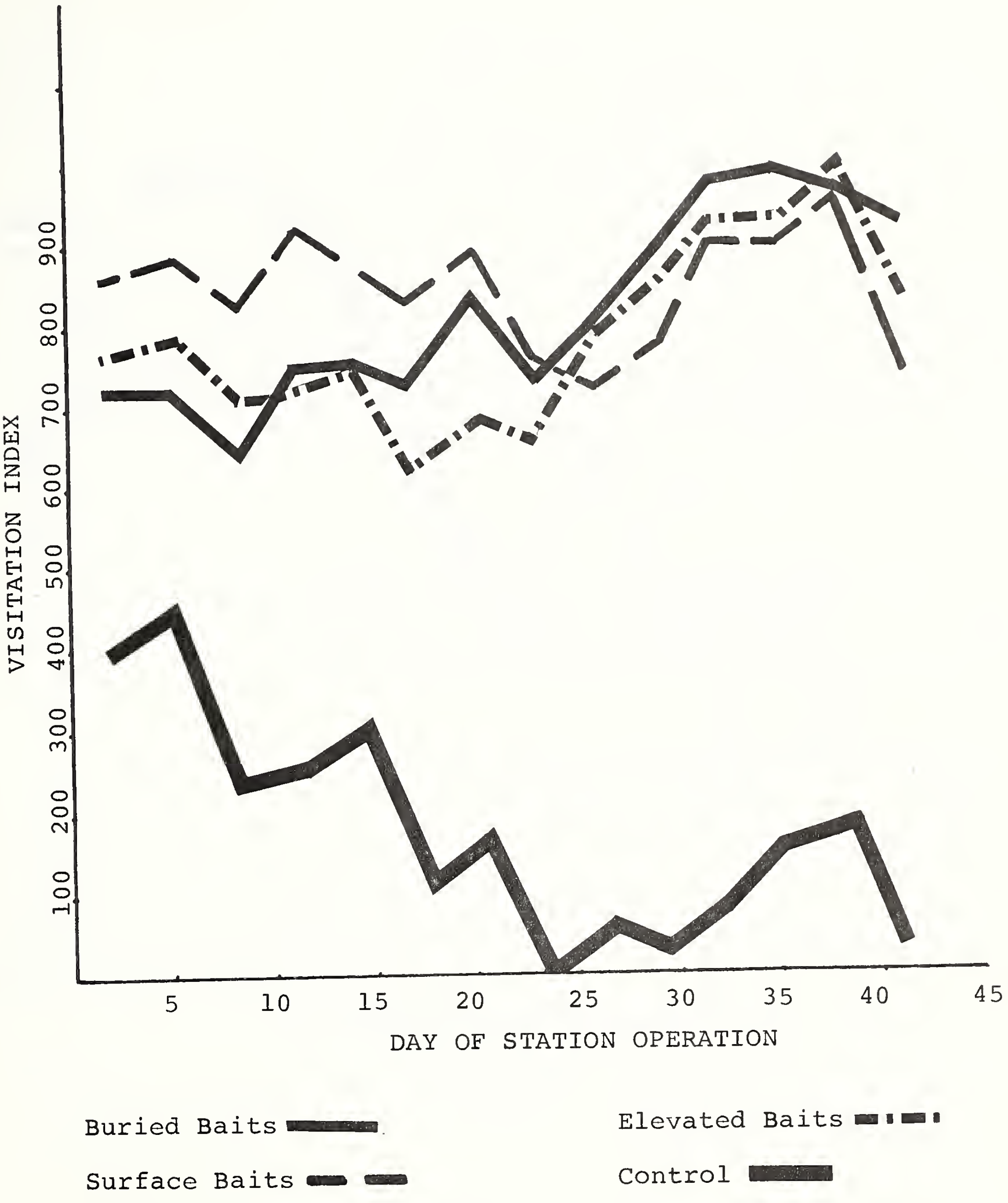
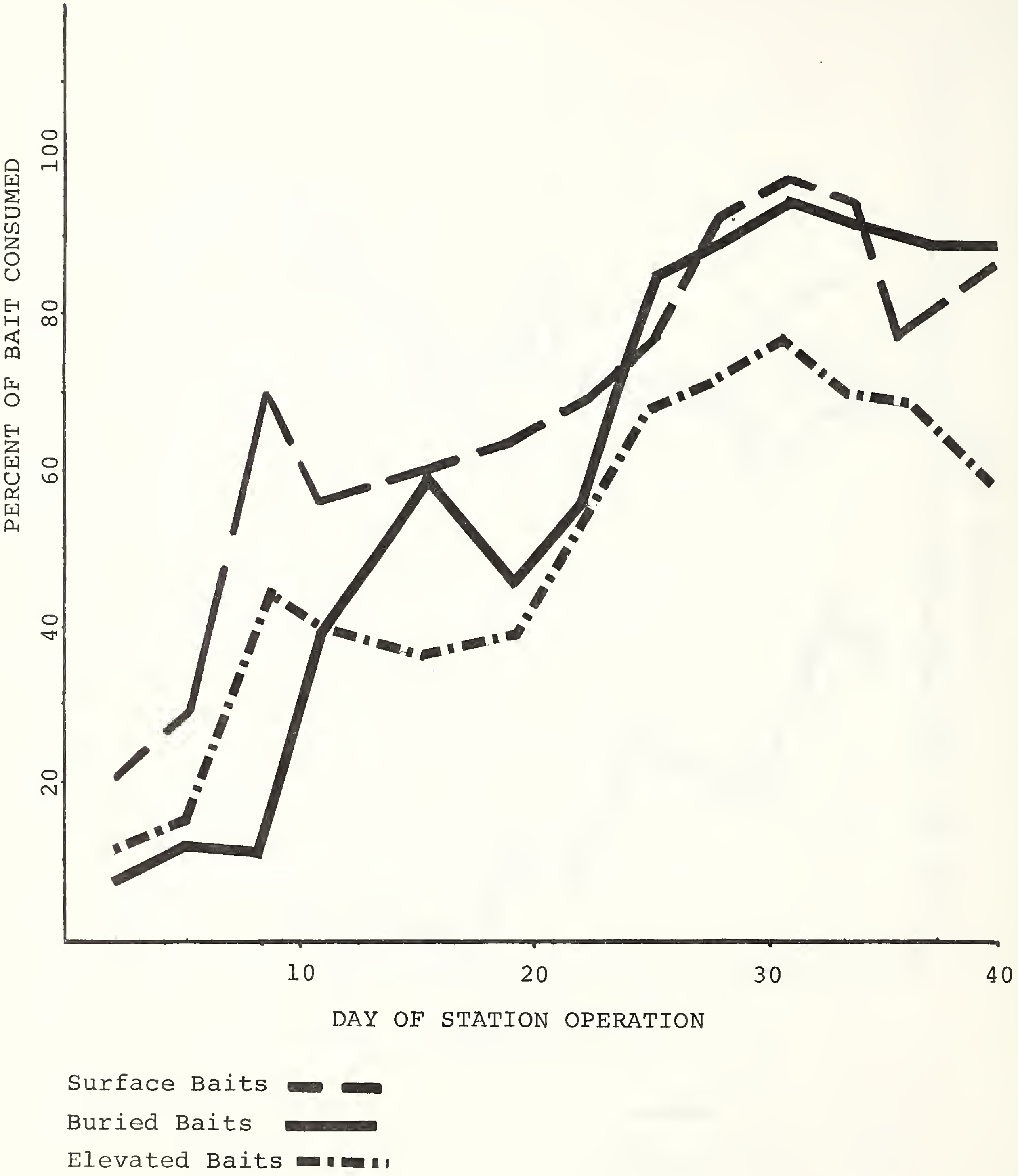


Figure 4. Temporal changes in average percentage of an SLD bait consumed per visit by small mammals.



was noted in bait consumption between buried and surface baits. Bait consumption for elevated baits was lower than for surface baits throughout the study.

Cattle

Cattle were the second most common visitors and were attracted to the baited, scented stations more frequently than to controls (Table 1). There was no significant difference among indices from baited stations but they differed significantly from the control. The high visitation rate at buried baits indicated that cattle may have been attracted by the SFE lure rather than visually attracted to baits. Other than precipitation, cattle visits were the usual reason for stations being inoperable. Often the number of cattle tracks completely obscurred and destroyed a station.

Bait consumption data for cattle (Table 2) indicates, probably incorrectly, that cattle consumed baits. Some question existed as to whether cattle actually consumed baits or caused bait disappearance by trampling or moving baits during their investigations of a station. In some instances, cattle tracks undoubtedly obscurred the tracks of animals who actually removed the baits. Servheen and Spillett (1981) also noted a high number of cattle visits in a similar study but suggested that cattle were not interested in the baits.

Coyotes

Average visitation indices to baited stations were higher than that for the control stations (p=0.05) (Table 1) and indicated some reluctance by coyotes to visit elevated baits. Analysis of variance showed no difference among indices from baited stations; however, visits to surface baits were significantly higher than those to controls by the multiple range test (Fig. 2).

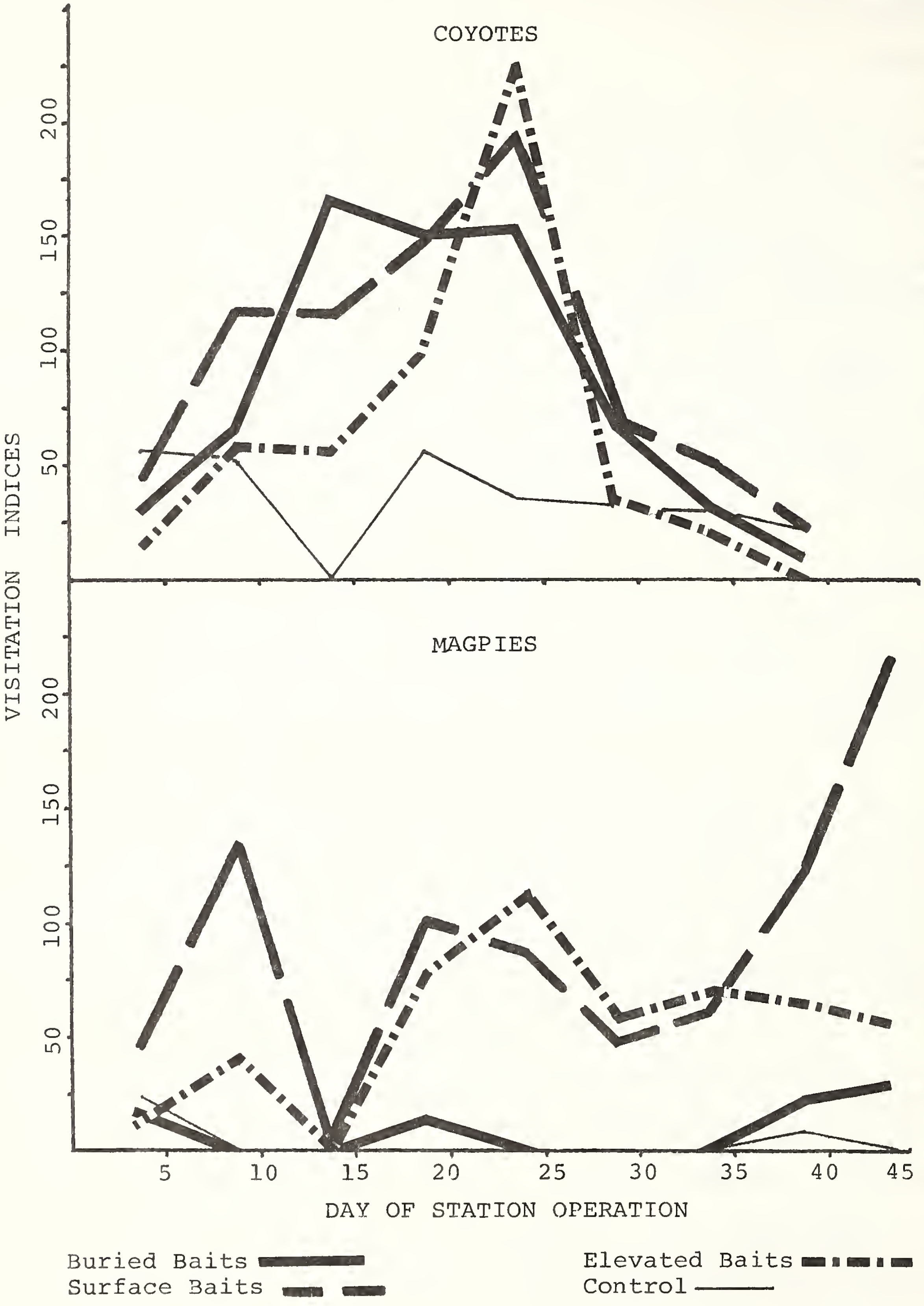
In terms of bait consumption per visit, coyotes either took an entire bait or none at all. Average bait consumption among the different bait placements probably did not differ significantly (Table 2). The number of times that coyotes were the single visitor to a station did not provide sufficient data to plot temporal changes in bait acceptance. However, these data indicated some early hesitance by coyotes to take baits. Up to day 10 of the study, baits were refused 5 times in 9 visits where coyotes were the only visitor. After day 10, when the majority of visits occurred, only one bait was refused in 47 visits.

A temporal change in coyote visitation rate occurred during the study (Fig. 5). Most visits occurred after day 8 and a marked decline in visits occurred after day 23 of station operation, at which time general big game hunting season commenced on the study area.

Black-billed Magpies

Magpies were attracted to elevated and surface baits but not to buried baits, indicating a visual response to the bait presence (Table 1). Indices at both control and buried baits were significantly different from that at surface baits. At visits to exposed baits, magpies displayed a ready

Figure 5. Temporal changes in average visitation indices to SLD baits for coyotes and magpies.



inclination to consume the bait (Table 2). In one case where a magpie was the single visitor to a buried bait, the bait was not consumed.

Temporal changes in visitation rates (Fig. 5) do not show any distinct trends in visitation. At day 14 visitation dropped to near zero during a period of inclement weather. Magpies may become accustomed to visiting certain stations, and possibly individual bait placements. Transects 3, 4, 5, 7 and 9, areas within 1 km. of riparian habitat along the Missouri River, received 95.6% of all magpie visits.

Instances where magpies were single visitors to stations did not provide sufficient data to show temporal changes in bait consumption. As with coyotes, there was an indication of an initial hesitance to take baits. Before day 10, 6 single visits by magpies were recorded, 4 of which resulted in less than 5% bait consumption. After day 10, in 19 visits, only 2 resulted in less than 5% bait consumption.

White-tailed and Mule Deer

Both white-tailed and mule deer were present on the study area, white-tails primarily in the riparian areas near the Missouri River. Deer were relatively common visitors at all stations, probably because of their abundance on the area but tended to avoid baited stations. The visitation index from the control was higher than any index from baited stations. Indices from control and buried bait stations were statistically higher than elevated baits (Fig. 2) indicating avoidance of exposed baits.

In 20 instances where deer were the single visitor to baited stations, no bait consumption occurred (Table 2).

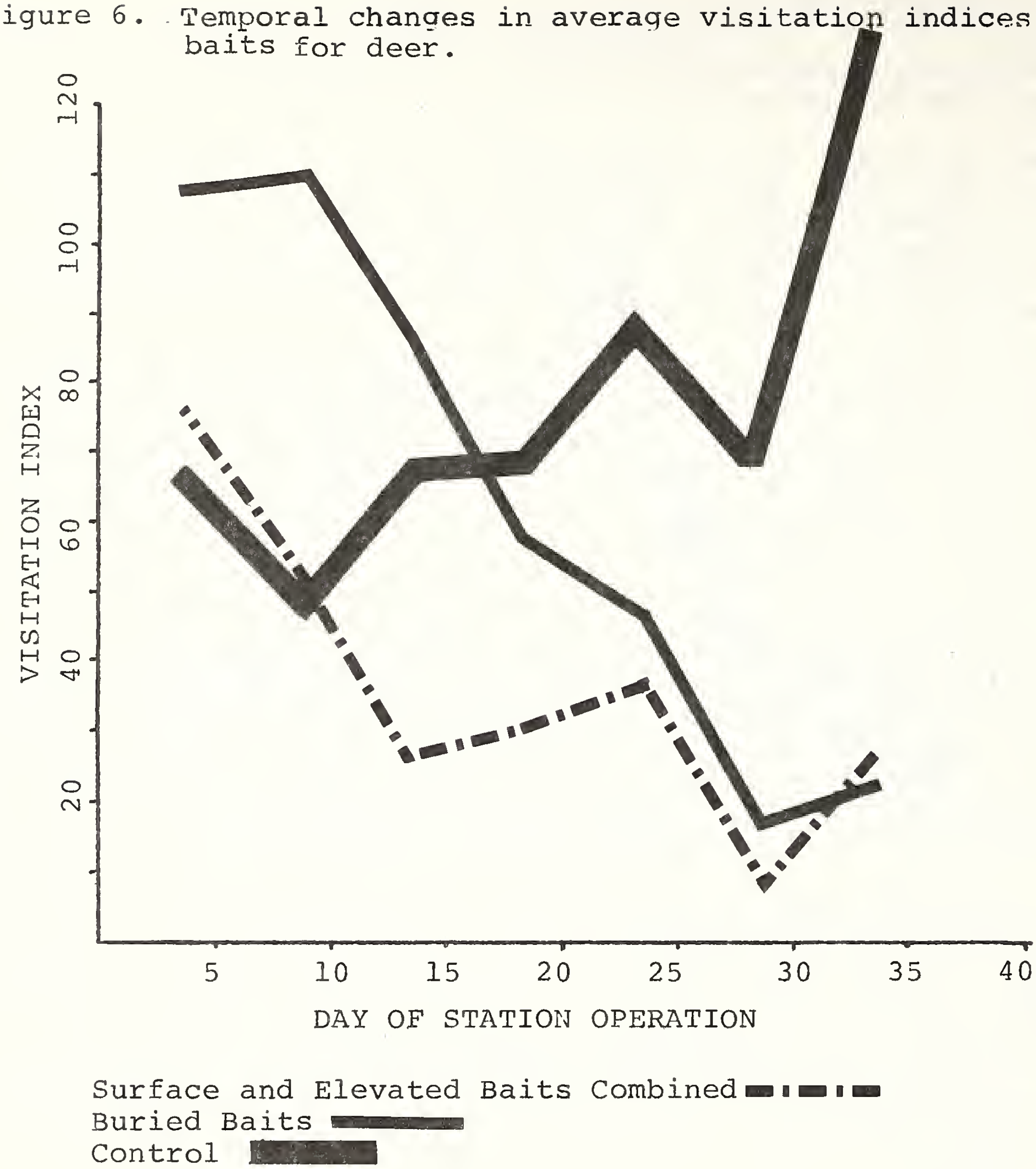
Deer visitation rates appeared to change temporally (Fig. 6). To graphically display these changes, the small number of observations for surface and elevated baits were combined because visitation indices indicated that deer reacted similarly to each of these bait placements. Deer visits declined for baited stations and appeared to increase at control stations over the duration of the study.

Striped Skunks

A total of 32 skunk visits were recorded at baited scent stations and none at control stations indicating a tendency to visit any type of bait placement. The visitation index at elevated baits was significantly lower than that at buried baits but not significantly different from surface baits (Fig. 2). Visitation indices at buried and surface baits were not statistically different. The majority of skunk visits (93.8%) occurred at transects 4, 5, 7, 8, and 9, areas close to the riparian habitat and bottomland near the Missouri River.

On all occasions (10) when skunks were the only visitor to a baited circle, baits were completely removed (Table 2).

Figure 6. Temporal changes in average visitation indices to SLD baits for deer.



Raccoons

Raccoons were also visitors at stations near riparian habitat and were apparently attracted to baited, scented stations (Table 1). Visitation to control stations, despite the low number of visits, indicates some inclination by raccoons to visit a cleared circle. In only 2 cases were raccoons the single visitor to a bait and in both cases the bait had been removed.

Other Visitors

Other animals that visited stations but with much less frequency included white-tailed jackrabbits (*Lepus townsendi*), mountain cottontails (*Sylvilagus nuttalli*), chipmunks (*Eutamias spp.*), elk (*Cervus elaphus*), pronghorn (*Antilocapra americana*), badgers (*Taxidea taxus*), mourning doves (*Zenaidura macroura*), sharp-tailed grouse (*Pedioecetes phasianellus*), insects (ants, field crickets, dermestid beetles, grasshoppers), millipedes, domestic dogs, and humans. These species probably include those that were not attracted by baits and/or scent, or those that were rare in occurrence on the study site.

Most species of insects were not present or were inactive at the time of the study. Nevertheless, insects visited baits in significantly higher numbers than controls (Table 1).

DISCUSSION

A sufficient amount of data was gathered to comment on the attractiveness and consumption of tallow-beeswax baits and SFE lure to coyotes, small mammals, magpies, deer, skunks, cattle and insects. With the exception of deer, the above species were attracted to the bait sets, and with the exception of deer and cattle, baits were readily consumed.

Certain other wildlife species were common on the study area but not attracted to scent stations, namely sage grouse (*Centrocercus urophasianus*), sharp-tailed grouse, white-tailed jackrabbits and golden eagles (*Aquila chrysaetos*).

The response of coyotes to SLD baits was of interest from the viewpoint of potential efficacy and safety of baits to other wildlife. The ease and speed at which coyotes can be elicited to approach and consume a bait influences the length of time a bait remains exposed to nontargets. The population of coyotes on the Missouri Breaks, while not typical of coyotes in an agricultural situation, were appropriate for this study. Because coyote hunting occurs over the study area, the population under study probably displayed some of the nuances of coyotes under human pressure, namely suspicion of unfamiliar changes or new objects in their environment (Ryden 1975).

The tallow-beeswax baits coated with fishmeal were readily accepted by coyotes that visited stations. For the delivery of a toxicant, this matrix is adequate until baits can be developed that are more palatable to coyotes but less attractive to nontarget wildlife.

Coyote visitation rates were higher at baited scent stations than at controls indicating some success, regardless of bait placement, in attracting coyotes to the baits. The visitation rate at buried baits, although lower than for surface baits, indicated that burying may be an acceptable method for presenting baits to coyotes. Despite a period of high visitation midway in the study (Fig. 5), elevated baits were visited far less than buried or surface baits. This may be related to an initial period of avoidance of elevated baits. Because of the poor average visitation rate, elevated baits may be a poor delivery method at this time despite their apparent potential for reducing small mammal consumption and visitation. If elevated baits are to be a viable delivery method, further work is needed to reduce the initial period of avoidance by coyotes.

Coyotes were apparently attracted to bait sets by both sight and smell. The coyote response to control circles indicated a visual response and the visitation to buried baits, an olfactive response to the SFE lure-bait combination. SFE-bait combination nearly doubled coyote visits to surface and buried baits compared to controls and, while SFE may not be the most effective lure in terms of attractiveness to coyotes, it does provide data for future comparison with other lures. As shown by the response of cattle, skunks, and small mammals to buried baits, SFE may be an attractant for other wildlife. Researchers are developing lures that are more specific towards coyotes and this may result in lures that are less attractive to other wildlife. Specifically, the WUL lure (R. Teranishi pers. comm.) and analysis of coyote estrous urine (Schultz et al. 1981), bear mentioning.

Coyote visits to cleared circles (control stations) were a phenomenon also reported by Servheen and Spillett (1981). They indicated that coyotes were attracted to cleared circles as a marking station, "dusting area", or as a matter of curiosity.

The temporal pattern of coyote visitation was interesting from a management standpoint. Initially, coyote visitation was low and control stations had more visits than baited stations (Fig. 5) indicating an initial reluctance by coyotes to visit baits. Ryden (1975) observed that coyotes, especially those within their denning areas, showed initial reluctance to approach new objects for several hours. Missouri Breaks coyotes apparently were reluctant to approach newly established baited scent stations for a number of days, but then appeared to show a rapid increase in tendency to visit baits. The initial establishment and daily checking of circles caused disturbance that would not be a part of operational coyote control programs and was probably responsible for much of the initial waryness of coyotes toward baits. Nevertheless, this behavior may be characteristic, more or less, toward habitat changes and emphasizes the importance of a minimal amount of disturbance during bait placement.

The dramatic decrease in coyote visitation that occurred at about day 23 (Fig. 5) may have been related to the onset of general big game hunting season and to an increase in the hunting of coyotes on the study site. The activity associated with deer and elk hunting and the appearance of internal organs, carcasses, and carrion as a new food source may have altered coyote behavior toward bait stations. Hunting was also responsible for the removal of several coyotes from near study stations.

Conducting this study during a period when coyote litters begin to break up and young of the year disperse (Pyrah 1980) may have influenced visitation rates. In the fall as coyotes become more active in their established ranges (Knowlton 1972) and litters disperse, a corresponding increase in visitation may occur. Young of the year may be less wary of bait stations and, as Pyrah (1980) observed, make repeat visits to stations. Visitation rates might be lower during late winter and early spring, when most operational use of baits would occur.

Unlike visitation, bait consumption by coyotes was not influenced by placement. Apparently, once coyotes approached the bait set, baits were accepted regardless of placement.

The effect of bait placement on visitations and consumption by wildlife other than coyotes was most dramatic for magpies. Burying baits nearly eliminated magpie visits and resulted in no bait consumption despite the attractiveness of the baits as evidenced by consumption at surface and elevated baits. The reduced average bait consumption by magpies at elevated baits, a difference of 37%, may demonstrate an increased margin of safety in elevated baits but not nearly as marked as buried baits. Other corvids (ravins and crows) may behave similarly toward the different bait placement. Tigner _et_. _al_. (1981) observed that buried baits were taken less by crows.

Burying or elevating baits did not significantly reduce average visitations by small mammals or cattle. The few number of visits by skunks and raccoons did not allow reliable conclusions on the effect of bait placement on visitation rate. There was a suggestion that elevated baits were visited less frequently by skunks.

The effects of placement on average bait consumed per visit are more pronounced. Consumption rates for small mammals were lower at both elevated (54%) and buried (68%) baits than at surface baits (72%). The difference in consumption between buried and surface baits is probably not significant in terms of an increased margin of safety for small mammals. Consumption of elevated baits by nontarget animals could possibly be further reduced by using wire instead of wood to elevate baits or by hanging baits, but the addition of novel variables might also further reduce coyote visits and consumption.

Cattle, even though attracted to scent stations probably as a curiosity or as a response to SFE or bait, probably did not consume baits. Their visits probably obscurred, at times, the tracks of wildlife responsible for removing baits. Deer, conversely, were repelled by the scent stations, more so as the study progressed (Fig 6). This was probably in response to increasing SFE residues at scent stations. SFE is marketed as a deer repellent. There was no indication of deer being attracted to or consuming baits.

Despite the low number of skunk visits, this species found and readily consumed surface and buried baits. On the only occasion where a skunk was the single visitor to an elevated bait, the bait was removed. The limited number of observations for raccoons indicated only that raccoons will remove baits.

Temporal trends in station visitation and bait consumption indicated that small mammals became accustomed to the scent stations as a food source. As the study progressed, visitations and bait consumption increased (Figs. 3 and

4) regardless of the method of bait placement. After about 3 weeks, visitation and consumption reached a maximum intensity so that nearly all stations were being visited and baits consumed by small mammals each night. At this point, baits probably did not remain in place long enough to be consumed by coyotes or any other wildlife. Visual observations also indicated that the intensity of a visit, or the number of individual small mammals at a station during one night, increased during the study. Early, only a few nightly visitors were noted; however, as the study progressed so did visit intensity so that after 2-3 weeks stations were completely covered with the prints of small mammals. From a management standpoint, these trends underscore the importance of bait sets aimed at attracting and eliciting offending coyotes to consume baits as quickly as possible. Indications from this study are, that in similar ecological situations, baits not consumed by coyotes will be consumed by small mammals within 5-8 days.

CONCLUSIONS

1. Coyotes were attracted to bait sets and readily consumed tallow-beeswax-fishmeal baits.

2. Small mammals (*Peromyscus* spp., *Dipodomys* spp., and *Microtus* spp.), magpies, skunks, and raccoons were attracted to scent stations and consumed baits. Cattle were attracted to scent stations but apparently did not consume baits. Deer were repelled by bait stations and did not consume baits.

3. Different bait placements had no effect on visitation by small mammals. Elevated baits were consumed less than buried or surface baits by small mammals. Consumption by small mammals at buried and surface baits was not apparently different. Buried baits were visited less and consumed less than elevated or surface baits by magpies. Skunks found and consumed baits regardless of placement, and raccoons may have done so as well.

4. Coyotes were initially reluctant to visit bait sets, a phenomenon that can be reduced in operational programs by creating minimal disturbance at bait locations.

5. Buried baits were adequately accepted by coyotes and reduced hazards of poisoning to birds. The elevated baits utilized in this study were not viable for operational baiting programs because of the reluctance of coyotes to visit them. Buried baits may be a potential poisoning hazard to small mammals, skunks, and raccoons.

ACKNOWLEDGEMENT

Appreciation is extended to Judith Johnson and Marilyn Wood for collection of field data, to Monty Sullins and Dan Sullivan for field assistance and review of the paper, to Duane Pyrah for conducting siren surveys, introducing us to the Missouri River Breaks and reviewing the paper, to Ralph Fries for permitting use of the CMR Wildlife Refuge and refuge facilities, and to George Algard, Don Ferlicka, Burt O'Gara, Dale Wade and John Weigand for review of the paper.

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APPENDIX I. Total visits and numbers of operable station nights for various species of wildlife visiting SLD baits.

Species	BURIED BAITS		SURFACE BAITS		ELEVATED BAITS		CONTROL	
	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits
Small Mammals	560	475	577	490	564	461	592	98
Cattle	584	95	591	73	591	80	594	42
Coyotes	554	35	575	44	562	27	591	21
Deer	555	30	576	23	563	16	592	49
Skunks	555	19	576	13	563	6	592	0
Raccoons	555	4	576	4	563	3	592	2
Lagomorphs	555	2	576	11	563	3	592	12
Chipmunks	555	0	576	3	563	2	592	0
Badgers	555	0	576	0	563	1	592	1
Elk	555	0	576	1	563	0	592	0
Pronghorn	555	0	576	1	563	0	592	0
Magpies	554	5	575	50	562	33	591	3
Sharp-tailed Grouse	555	0	576	0	563	0	592	1
Doves	555	0	576	0	563	1	592	0
Small Birds	555	2	576	1	563	3	592	2
Insects	555	2	576	11	563	2	592	0

APPENDIX II. Operable station nights and wildlife visits to SLD baits for major wildlife species and cattle on the Missouri River Breaks.

SMALL MAMMALS

Transect	BURIED BAITS		SURFACE BAITS		ELEVATED BAITS		CONTROL	
	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits
1	35	33	36	33	34	29	36	18
2	34	30	35	33	32	22	36	3
3	30	27	35	21	25	22	36	5
4	33	26	34	32	35	12	35	3
5	33	33	32	32	30	24	34	2
6	31	23	35	32	35	35	35	5
7	25	24	31	9	32	30	32	3
8	28	23	28	19	28	16	29	3
9	27	11	29	18	28	14	27	4
10	31	17	32	32	32	32	32	7
11	27	22	23	17	26	22	27	3
12	24	24	25	24	24	24	25	3
13	22	22	23	22	23	23	24	2
14	24	23	22	22	24	22	24	12
15	27	22	27	24	28	20	28	8
16	27	25	28	25	28	23	28	3
17	28	25	28	23	28	26	28	2
18	21	14	21	19	19	14	23	2
19	28	28	28	28	28	28	28	8
20	25	23	25	25	25	23	25	2
TOTAL	560	475	577	490	564	461	592	98

CATTLE

Transect	BURIED BAITS		SURFACE BAITS		ELEVATED BAITS		CONTROL	
	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits
1	35	3	36	5	35	4	36	4
2	35	15	36	5	36	9	36	5
3	36	23	36	11	36	21	36	3
4	35	7	35	4	35	4	35	9
5	34	2	34	11	33	6	34	0
6	31	7	35	4	35	4	35	4
7	30	7	31	3	32	5	32	3
8	28	1	28	0	29	1	29	1
9	29	1	30	1	29	1	28	0
10	31	1	32	0	32	1	32	0
11	27	2	27	5	27	6	27	1
12	26	5	26	3	25	4	26	3
13	23	1	23	2	23	2	24	2
14	24	6	22	6	24	2	24	5
15	28	4	28	4	28	1	28	1
16	28	1	28	2	28	1	28	0
17	28	2	28	3	28	1	28	0
18	23	6	23	3	23	7	23	1
19	28	1	28	1	28	0	28	0
20	25	0	25	0	25	0	25	0
TOTAL	584	95	591	73	591	80	594	42

COYOTES

Transect	BURIED BAITS		SURFACE BAITS		ELEVATED BAITS		CONTROL	
	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits
1	35	1	36	1	34	0	36	1
2	32	0	34	1	32	0	36	0
3	27	0	35	5	26	0	36	0
4	33	3	34	5	35	2	35	0
5	32	0	32	0	30	0	34	1
6	31	1	35	1	35	1	35	1
7	25	1	31	6	30	1	32	4
8	28	1	28	1	28	1	29	3
9	27	7	29	6	28	4	27	0
10	31	1	32	0	32	0	32	3
11	27	4	23	4	26	4	27	4
12	24	0	25	0	23	0	25	0
13	22	1	23	0	23	0	24	0
14	24	1	22	1	24	2	24	0
15	27	8	27	2	28	2	28	2
16	27	0	28	5	28	5	28	1
17	28	3	28	4	28	4	28	0
18	21	2	20	2	19	1	22	1
19	28	0	28	0	28	0	28	0
20	25	1	25	0	25	0	25	0
TOTAL	554	35	575	44	562	27	591	21

DEER

Transect	BURIED BAITS		SURFACE BAITS		ELEVATED BAITS		CONTROL	
	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits
1	35	0	36	0	34	1	36	0
2	32	0	34	0	32	1	36	0
3	27	3	35	5	26	0	36	3
4	33	6	34	3	35	4	35	21
5	32	4	32	0	30	0	34	1
6	31	1	35	0	35	0	35	2
7	25	0	31	2	30	0	32	1
8	28	0	28	5	28	1	29	3
9	28	4	30	2	29	3	28	1
10	31	2	32	1	32	1	32	6
11	27	2	23	1	26	0	27	1
12	24	1	25	0	23	0	25	1
13	22	2	23	2	23	0	24	3
14	24	1	22	0	24	0	24	0
15	27	1	27	0	28	5	28	1
16	27	0	28	0	28	0	28	1
17	28	1	28	1	28	0	28	3
18	21	0	20	0	19	0	22	0
19	28	1	28	1	28	0	28	1
20	25	1	25	0	25	0	25	0
TOTAL	555	30	576	23	563	16	592	49

MAGPIES

Transect	BURIED BAITS		SURFACE BAITS		ELEVATED BAITS		CONTROL	
	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits
1	35	0	36	0	34	0	36	0
2	32	0	34	0	32	0	36	0
3	27	0	35	14	26	1	36	0
4	33	1	34	4	35	19	35	1
5	32	1	32	2	30	9	34	1
6	31	0	35	0	35	0	35	0
7	25	0	31	17	30	0	32	1
8	28	0	28	0	28	1	29	0
9	27	1	29	12	28	3	27	0
10	31	2	32	0	32	0	32	0
11	27	0	23	0	26	0	27	0
12	24	0	25	0	23	0	25	0
13	22	0	23	0	23	0	24	0
14	24	0	22	0	24	0	24	0
15	27	0	27	0	28	0	28	0
16	27	0	28	0	28	0	28	0
17	28	0	28	0	28	0	28	0
18	21	0	20	0	19	0	22	0
19	28	0	28	1	28	0	28	0
20	25	0	25	0	25	0	25	0
TOTAL	554	5	575	50	562	33	591	3

SKUNKS, RACCOONS[1]

Transcect	BURIED BAITS		SURFACE BAITS		ELEVATED BAITS		CONTROL	
	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits	Operable Nights	Visits
1	35	0	36	0	34	0	36	0
2	32	0	34	0	32	0	36	0
3	27	0	35	0	26	0	36	0
4	33	2(1)	34	3	35	2	35	0(1)
5	32	2	32	0	30	0	34	0
6	31	0	35	0	35	0	35	0
7	25	3	31	0(2)	30	0	32	0
8	28	6(1)	28	2	28	3(3)	29	0(1)
9	27	6(2)	29	6(2)	28	1	27	0
10	31	0	32	1	32	0	32	0
11	27	0	23	0	26	0	27	0
12	24	0	25	0	23	0	25	0
13	22	0	23	0	23	0	24	0
14	24	0	22	0	24	0	24	0
15	27	0	27	0	28	0	28	0
16	27	0	28	0	28	0	28	0
17	28	0	28	0	28	0	28	0
18	22	0	21	0	20	0	23	0
19	28	0	28	1	28	0	28	0
20	25	0	25	0	25	0	25	0
TOTAL	555	19(4)	576	13(4)	563	6(3)	592	0(2)

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[1] Raccoons in parenthesis.